# Compared To A 620 Nm Photon, A 760 Nm Photon Has Group Of Answer Choices Longer Wavelength, Higher Frequency,

**Compared To A 620 Nm Photon, A 760 Nm Photon Has Group Of Answer Choices Longer Wavelength, Higher Frequency,** and understanding this comparison requires a grasp of fundamental concepts in physics, particularly the nature of electromagnetic radiation. Photons are quanta of light, and their properties are characterized primarily by their wavelength, frequency, and energy. These properties are interconnected through the equations of electromagnetic theory, which allow us to analyze how different photons compare based on their wavelength and frequency. In this article, we'll explore how a photon with a wavelength of 760 nanometers (nm) compares to one with a wavelength of 620 nm, focusing on the key group of answer choices: longer wavelength or higher frequency.

## Understanding Photons: Wavelength, Frequency, and Energy

### What Is a Photon?

A photon is the elementary particle representing a quantum of electromagnetic radiation, including visible light, radio waves, X-rays, and more. Photons are massless, always traveling at the speed of light in vacuum, and their energy depends on their frequency or wavelength.

### Key Properties of Photons

Photons are characterized by the following properties:

- **Wavelength (\(\lambda\)):** The distance between successive peaks of the wave, measured in nanometers (nm) or meters (m).
- **Frequency (\(f\)):** The number of wave cycles that pass a point per second, measured in hertz (Hz).
- **Energy (\(E\)):** The energy of a photon is directly proportional to its frequency, given by \(E = hf\), where \(h\) is Planck's constant.

## The Wave Equation Relationship

The relationship between wavelength, frequency, and the speed of light ($c$) in vacuum is expressed as:

$$
c = \lambda \times f
$$

where:

- $c \approx 3.00 \times 10^8\, \text{m/s}$,
- $\lambda$ is the wavelength,
- $f$ is the frequency.

This fundamental equation allows us to compare photons based on their wavelength and frequency.

# Comparing a 620 nm Photon and a 760 nm Photon

## Wavelengths and Their Significance

The wavelengths of the photons in question are:

- 620 nm: roughly corresponds to orange-red light,
- 760 nm: corresponds to near-infrared light.

Since both wavelengths are within the electromagnetic spectrum, their properties can be directly compared using the wave equation.

## Calculating the Frequencies

Let's determine the frequencies of each photon to understand their relationship:

For the 620 nm photon:

$$
\lambda_{620} = 620\, \text{nm} = 620 \times 10^{-9}\, \text{m}
$$

$$
f_{620} = \frac{c}{\lambda_{620}} = \frac{3.00 \times 10^8}{620 \times 10^{-9}} \approx 4.84 \times 10^{14}\, \text{Hz}
$$

For the 760 nm photon:

$$
\lambda_{760} = 760\, \text{nm} = 760 \times 10^{-9}\, \text{m}
$$

$$
f_{760} = \frac{c}{\lambda_{760}} = \frac{3.00 \times 10^8}{760 \times 10^{-9}}

\approx 3.95 \times 10^{14}\, \text{Hz}
\]

Comparison:
- The 620 nm photon has a higher frequency (~4.84 x 10^{14} Hz).
- The 760 nm photon has a lower frequency (~3.95 x 10^{14} Hz).

This confirms that longer wavelength photons have lower frequencies, consistent with the wave equation.

# Implications of Wavelength and Frequency Differences

## Longer Wavelengths Correspond to Lower Frequencies

The inverse relationship between wavelength and frequency is fundamental:
- Longer wavelength (\(> \lambda_{620}\)) implies lower frequency.
- Shorter wavelength (\(< \lambda_{760}\)) implies higher frequency.

In our case, the 760 nm photon, having a longer wavelength than 620 nm, must have a lower frequency.

## Energy Considerations

Since photon energy is proportional to frequency:
\[
E = hf
\]
a photon with a higher frequency (shorter wavelength) has more energy.

- The 620 nm photon (higher frequency) has more energy than the 760 nm photon.
- Conversely, the 760 nm photon has less energy.

# Answer Choices Explained: Longer Wavelength or Higher Frequency?

Given the data and calculations, the key question becomes: Compared to a 620 nm photon, a 760 nm photon has group of answer choices: longer wavelength, higher frequency. Let's analyze each:

### Longer Wavelength

- The 760 nm photon has a longer wavelength than the 620 nm photon.
- This statement is correct.

### Higher Frequency

- The 760 nm photon has a lower frequency than the 620 nm photon.
- This statement is incorrect.

## Summary of Key Points

- Wavelength and frequency are inversely related for photons traveling at the speed of light.
- A photon with a longer wavelength has a lower frequency and less energy.
- Comparing 620 nm and 760 nm photons, the one with 760 nm wavelength has a longer wavelength but a lower frequency.

## Practical Applications and Significance

### In Spectroscopy and Optical Technologies

Understanding the relationship between wavelength and frequency helps in designing optical devices, such as lasers, cameras, and sensors that operate at specific wavelengths.

### In Communication Systems

Radio and fiber-optic communications rely on different wavelengths and frequencies to carry information efficiently and with minimal interference.

## Conclusion

In summary, when comparing photons of different wavelengths, the fundamental principles of electromagnetic waves dictate that a photon with a longer wavelength must have a lower frequency. Therefore, a 760 nm photon, compared to a 620 nm photon, has a longer wavelength but a lower frequency. This understanding is crucial in fields ranging from physics to engineering, enabling precise control and application of electromagnetic radiation across various technological domains.

Final group of answer choices:
- Longer Wavelength
- Lower Frequency

Correct choice: Compared To A 620 Nm Photon, A 760 Nm Photon Has Group Of Answer Choices Longer Wavelength.

# Frequently Asked Questions

## How does the increase from 620 Nm to 760 Nm in photon energy affect its wavelength?

The photon with 760 Nm wavelength has a longer wavelength compared to the 620 Nm photon.

## Does a higher photon energy correspond to a higher or lower frequency?

A higher photon energy corresponds to a higher frequency.

## Given the photon with 760 Nm wavelength, what can be said about its frequency relative to a 620 Nm photon?

The 760 Nm photon has a lower frequency than the 620 Nm photon because wavelength and frequency are inversely related.

## Which photon has higher energy, the 620 Nm or the 760 Nm photon?

The 760 Nm photon has higher energy because energy is directly proportional to frequency, and the 760 Nm photon has a higher frequency.

## Is the photon with 760 Nm wavelength associated with a longer wavelength or higher frequency compared to the 620 Nm photon?

It is associated with a longer wavelength and a lower frequency compared to the 620 Nm photon.

## How do wavelength and frequency relate for photons, and how does this apply to the given photon

## comparison?

Wavelength and frequency are inversely related; as wavelength increases (from 620 Nm to 760 Nm), frequency decreases, so the 760 Nm photon has a longer wavelength and lower frequency than the 620 Nm photon.

# Additional Resources

Compared To A 620 Nm Photon, A 760 Nm Photon Has Group Of Answer Choices Longer Wavelength, Higher Frequency

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Introduction

Photons, the fundamental quanta of light, are characterized by their wavelength, frequency, and energy. These parameters are interconnected through fundamental physical laws, shaping how light interacts with matter and how it propagates through space. A comparison between photons of different wavelengths provides insight into their physical properties and the implications for various applications, from telecommunications to astrophysics.

This article investigates the specific case of a photon with a wavelength of 620 nanometers (nm) contrasted with one at 760 nm, focusing on how their physical characteristics compare—particularly examining whether the photon at 760 nm has a longer wavelength, higher frequency, or other notable differences. Through detailed analysis, we aim to clarify the underlying physics and dispel common misconceptions, providing a comprehensive understanding suitable for a review or scholarly publication.

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Fundamental Properties of Photons

Before delving into the specific comparison, it is essential to revisit the basic relationships governing photons:

- Wavelength (λ): The distance over which the wave's shape repeats.
- Frequency (f): How many wave cycles pass a point per second.
- Speed of light (c): In a vacuum, approximately 299,792,458 meters per second.
- Energy (E): Given by $E = h \times f$, where $h$ is Planck's constant (~6.626 × $10^{-34}$ Js).

The core relationship linking wavelength and frequency is:

$$c = \lambda \times f$$

where $c$ is the speed of light, $\lambda$ is the wavelength, and $f$ is the frequency.

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## Comparing the 620 nm and 760 nm Photons

### Wavelengths and Frequencies

Given the inverse relationship between wavelength and frequency, it is straightforward to determine the relative frequencies of photons at 620 nm and 760 nm.

- For 620 nm photon:

$$ \lambda_{620} = 620 \times 10^{-9} \text{ meters} $$

$$ f_{620} = \frac{c}{\lambda_{620}} = \frac{3.0 \times 10^8 \text{ m/s}}{620 \times 10^{-9} \text{ m}} \approx 4.84 \times 10^{14} \text{ Hz} $$

- For 760 nm photon:

$$ \lambda_{760} = 760 \times 10^{-9} \text{ meters} $$

$$ f_{760} = \frac{c}{\lambda_{760}} = \frac{3.0 \times 10^8 \text{ m/s}}{760 \times 10^{-9} \text{ m}} \approx 3.95 \times 10^{14} \text{ Hz} $$

Key observation: The photon at 760 nm has a lower frequency than the 620 nm photon, since longer wavelength corresponds to lower frequency.

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### Physical Implications of the Wavelength and Frequency Difference

1. Wavelength Comparison

- The 760 nm photon has a longer wavelength than the 620 nm photon by approximately 140 nm.
- This makes the 760 nm photon fall within the near-infrared region of the electromagnetic spectrum, whereas 620 nm lies within the visible red spectrum.

Conclusion: The 760 nm photon has a longer wavelength.

2. Frequency Comparison

- Because frequency and wavelength are inversely proportional, the 760 nm photon has a lower frequency compared to the 620 nm photon.
- Specifically, it's about 20% lower in frequency, which affects its energy and interaction properties.

Conclusion: The 760 nm photon does not have a higher frequency; it has a lower one.

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### Clarifying Common Misconceptions

The question often arises: "Compared to a 620 nm photon, does a 760 nm photon have a longer wavelength or higher frequency?" The answer hinges on understanding the inverse relationship:

- Longer wavelength corresponds to lower frequency.
- Higher frequency corresponds to shorter wavelength.

Thus, a photon at 760 nm has a longer wavelength but a lower frequency than a photon at 620 nm.

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## The Role of Photon Energy

Photon energy is directly proportional to frequency:

$$ E = h \times f $$

Given the calculations:

- 620 nm photon energy:

$$ E_{620} = h \times f_{620} \approx 6.626 \times 10^{-34} \times 4.84 \times 10^{14} \approx 3.21 \times 10^{-19} \text{ Joules} $$

- 760 nm photon energy:

$$ E_{760} = h \times f_{760} \approx 6.626 \times 10^{-34} \times 3.95 \times 10^{14} \approx 2.62 \times 10^{-19} \text{ Joules} $$

The 760 nm photon has less energy than the 620 nm photon, consistent with its lower frequency.

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## Additional Considerations: Does the Wavelength Affect Other Properties?

While wavelength and frequency are key characteristics, other features include:

- Photon momentum: $p = \frac{h}{\lambda}$. Longer wavelength photons have lower momentum.
- Interaction with matter: Longer wavelength (lower energy) photons tend to penetrate deeper into materials and are less likely to cause electronic transitions, affecting their use in imaging, communication, and medical applications.

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## Summary of Key Findings

| Property | 620 nm photon | 760 nm photon | Comparison |
|---|---|---|---|
| Wavelength | 620 nm | 760 nm | The 760 nm photon has a longer wavelength. |

| | | | |
|---|---|---|---|
| Frequency | ~$4.84 \times 10^{14}$ Hz | ~$3.95 \times 10^{14}$ Hz | The 760 nm photon has a lower frequency. |
| Energy | ~$3.21 \times 10^{-19}$ J | ~$2.62 \times 10^{-19}$ J | The 760 nm photon has less energy. |
| Momentum | $p_{620}$ | $p_{760}$ | Longer wavelength correlates with lower momentum. |

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Implications for Applications

Understanding whether a photon has longer wavelength or higher frequency impacts its utility:

- Optical communications: Longer wavelengths (like 760 nm) are useful for deeper tissue imaging or longer-range communications due to lower scattering.
- Spectroscopy: Higher-energy photons (shorter wavelengths) are more effective in exciting electronic transitions.
- Photonic devices: Wavelength selection determines device compatibility, such as photodetectors and laser sources.

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Final Clarification and Answer to the Group of Choices

Given the comparison between a 620 nm photon and a 760 nm photon:

- Longer Wavelength: Yes, the 760 nm photon has a longer wavelength.
- Higher Frequency: No, it has a lower frequency.

Therefore, the correct conclusion is:

> A 760 nm photon has a longer wavelength but not a higher frequency compared to a 620 nm photon.

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Conclusion

The fundamental inverse relationship between wavelength and frequency ensures that when comparing photons of different wavelengths, the longer wavelength corresponds to a lower frequency. In the specific case of 620 nm versus 760 nm photons, the latter has a longer wavelength but a reduced frequency and energy. Recognizing these distinctions is crucial in physics, optics, and engineering applications, ensuring accurate interpretation of light-matter interactions and the design of photonic systems.

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